PRINT QUEUE MANAGER

BACKGROUND OF THE INVENTION

5 Field of the Invention

        The invention concerns the administration of printing devices in a network environment. In particular, the invention concerns the creation and management of print queues corresponding to printing
10 devices connected on a network.

Incorporation By Reference

        U.S. Patent Application No. 09/664,531, entitled "Object-Based Architecture For Supporting
15 Network Devices," filed September 18, 2000, is incorporated by reference as if fully set forth in full herein.

Description of the Related Art
20   The administration of printing devices in a network environment is typically a tedious and time consuming task for network administrators. In particular, for large and complex network environments having several local servers, there may be a large
25 number of printers distributed throughout the network. Network administrators must not only install new printing devices on the network, they must also create and manage the print queues associated with the

printing devices and facilitate network users
connecting to and utilizing the printing devices.

    In large computer networking environments,
the administrative tasks required to create and
5 configure print queues associated with printing devices
connected to the network can be demanding. For
example, when creating a print queue for a printing
device, a network administrator generally must manually
enter information such as the address assigned to the
10 printing device, the particular type of printing
device, and the configuration or capabilities of the
printing device. As the number of printing devices
increases, the time and effort required to obtain the
needed information and create and configure the
15 necessary print queues can become excessively
burdensome.

    Once a print queue has been created and
configured for a particular printing device, network
users may begin utilizing the printing device by
20 locating and connecting to the desired print queue, and
installing any necessary print drivers. However,
searching for the desired print queue often requires
the network user to search lists of print queues on
multiple network servers. In networking environments
25 employing a large number of servers, finding a desired
print queue can be confusing and very time consuming.

    As printing devices within an existing
computer network are relocated or reassigned addresses,
typically a network administrator must update the
30 configuration stored for the respective print queues to
reflect any change of address on the network.
Additionally, if the name of a print queue is changed,
all user workstations using that particular print queue
must be updated with the new name or the user
35 workstations will lose their connection to the printing
device. As the size of the computer network increases,
updating print queue configuration information and

ensuring all workstations have updated print queue
names becomes very time consuming.

SUMMARY OF THE INVENTION

5   The present invention addresses the foregoing
problems by providing for the automatic creation and
configuration of print queues upon detecting printing
devices on a network. Specifically, the invention
detects new printing devices connected on a network.
10 Upon detection of a printing device, information is
obtained from the detected printing device and a print
queue is created. Accordingly, the present invention
helps reduce the burden of manually creating and
configuring print queues for connected printing
15 devices.

One aspect of the invention concerns
detecting a printing device connected on a network and
requesting information from the detected printing
device. The requested information is received from the
20 printing device and a print queue is created for the
printing device based on the received information.

The invention preferably includes detecting a
printing device by detecting an address assignment
message sent between an address server and the printing
25 device over the network. The invention also includes
detecting the printing device by sending a request
message to a plurality of network addresses and
receiving a response message from the printing device
located at one of the network addresses. Additionally,
30 the invention includes detecting a printing device by
broadcasting a request message over a network and
receiving a response message from the printing device
connected on the network.

The invention also preferably includes
35 publishing the newly created print queue to the
network. Additionally, it is preferable to create a
print queue entry in a print queue configuration

database that includes configuration data related to
the print queue. Preferably a web page is created
containing links representing each of the print queues
with entries in the print queue configuration database.
5 By selecting a link on the web page, a user can
preferably configure a workstation to print to the
print queue represented by the link. It is also
preferable to detect a new IP address of one of the
printing devices and update both the configuration of
10 the print queue corresponding to the printing device
and the configuration data in the print queue entry of
the configuration database corresponding to the
printing device. Finally, it is preferable to detect
new identification information of a print queue and
15 update a connection between a network workstation and
the print queue to reflect the new identification
information.

        By virtue of the foregoing, print queues are
created and configured upon detection of a printing
20 device. In addition, changes in printing device
addresses or print queue identification information are
updated in the corresponding print queue
configurations, and network workstations are notified
of the changes. Accordingly, tedious and time
25 consuming tasks involved in the management of network
printing devices are reduced.

        This brief summary has been provided so that
the nature of the invention may be understood quickly.
A more complete understanding of the invention can be
30 obtained by reference to the following detailed
description of the preferred embodiment in connection
with the attached drawings.

                BRIEF DESCRIPTION OF THE DRAWINGS
35   Figure 1 is a depiction of a network
environment in which the present invention may be
practiced.

Figure 2 is a block diagram illustrating an internal architecture a network management device according to one embodiment of the present invention.

Figure 3 is a block diagram depicting directories for use in one embodiment of the present invention.

Figure 4 is a block diagram depicting servers for use in one embodiment of the present invention.

Figure 5 is a block diagram depicting software modules for use in one embodiment of the present invention.

Figure 6 is a block diagram depicting the web pages for use in one embodiment of the present invention.

Figure 7 is a block diagram depicting a device management directory for use in one embodiment of the present invention.

Figure 8 is a block diagram depicting a print queue configuration directory for use in one embodiment of the present invention.

Figure 9 is a block diagram illustrating the functionality of one embodiment of the present invention in a network environment.

Figure 10 is a flowchart depicting a process for creating print queues corresponding to network printing devices.

Figure 11 is a flowchart depicting a process for configuring client workstations.

Figure 12 is a flowchart depicting a process for monitoring and updating network printing device address information.

Figure 13 is a flowchart depicting a process for updating connections with new identification information.

Figure 14 is a flowchart depicting a process for manual creation of print queues.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 depicts a network environment in which the present invention may be practiced. As seen in Figure 1, network 10 is provided which is a typical
5 network that is supported by TCP/IP and other protocols as discussed further herein. Connected to network 10 are workstations 11 and 12, server 14, printers 15, 16, 17 and 18, laptop 19 and network management device 20. Network management device 20 is used to implement the
10 present invention for managing a plurality of network devices, such as network printers 15, 16, 17 and 18. The configuration and functionality of network management device 20 is discussed in more detail below. In this regard, the invention is described below with
15 respect to management of network printers; however, it should be appreciated that the present invention of network management device 20 can be used to manage any type of network device.

Workstations 11 and 12 are typical computing
20 workstations having host processor 26 for supporting user interface 29, thereby allowing a user of either one of workstations 11 or 12 to work with typical applications, such as word processing, and to access functional services provided by other devices on
25 network 10, such as printing services.

Server 14 is a typical server having host processor 30 which includes a large fixed disk for containing files and/or applications which can be accessed and shared by other users on network 10.
30 Server 14 also has display 31 for supporting user interface 32. Laptop 19 is a conventional laptop computer having a host processor and display, thereby allowing it to operate in a manner similar to workstations 11 and 12.

35 Figure 2 is a block diagram for explaining the internal architecture of network management device 20. As seen in Figure 2, network management device 20

has a configuration similar to that of a server and
includes server bus 40, CPU 41, RAM 42, ROM 47, network
interfaces 44 and 45, front panel interface 46 and
fixed disk 50. CPU 41 is a programmable microprocessor
5   which is interfaced to server bus 40. RAM 42
interfaces to server bus 40 to provide CPU 41 with
access to memory storage, thereby acting as the main
run time memory for CPU 41. In particular, when
executing stored program instruction sequences, CPU 41
10 loads the instruction sequences from fixed disk 50 (or
other memory media) into RAM 42 and executes those
stored program instruction sequences out of RAM 42. It
should also be recognized that standard disk-swapping
techniques allow segments of memory to be swapped to
15 and from RAM 42 and fixed disk 50.
        ROM 47 stores invariant instruction
sequences, such as startup instruction sequences for
CPU 41 or basic input/output operating system ("BIOS")
sequences for the operation of any peripheral devices
20 which may be attached to server 11 (not shown).
Network interfaces 44 and 45 provide two separate and
distinct network interfaces, thereby allowing network
management device 20 to connect to two separate
networks as discussed further below. As seen in Figure
25 2, network interfaces 44 and 45 each have respective
protocols 48 and 49 for supporting communication of
network management device 20 over network 10 with other
devices on network 10. For example, protocols 48 and
49 can include, but are not limited to, TCP/IP, HTTP,
30 SNMP, DHCP, and other known network protocols,
including a variety of known printing protocols.
        Front panel interface 46 provides the
interface to front panel 21 provided on network
management device 20, thereby allowing a user such as a
35 system administrator to monitor and input configuration
information and other commands and instructions to
network management device 20.

Fixed disk 50 is one example of a computer-readable medium that stores program instruction sequences which are executable by CPU 41 so as to constitute operating system 51, front panel interface driver 52, network interface drivers 53, directories 54, servers 55, software modules 56, web pages 57, print jobs 58, print queue policy rules 59, print drivers 60, print queues 61, and other files 62. Operating system 51 can be an operating system such as DOS, or a windowing operating system for networks such as Windows NT, or can be another operating system such as Unix. Front panel interface driver 52 is provided for supporting front panel interface 46 to communicate with front panel 21. Network interface drivers 53 support network interfaces 44 and 45 for allowing network management device 20 to communicate with two separate networks, as discussed above. Directories 54 contain directories for use to implement the present invention for managing a plurality of print devices on the network and are discussed further below. Servers 55 contain necessary protocol servers and other servers for implementing the present invention and are discussed further below. Software modules 56 are utilized to implement the present invention as discussed further below. Web pages 57 comprise web pages which are accessible by users on network 10 or by a system administrator on network 10 to access functional services of printing devices on network 10 and to manage the configuration of network management device 20 and of a plurality of printing devices which are managed by network management device 20 as described further below. Print jobs 58 consist of print jobs received by network management device 20 from users on network 10, such as workstations 11 and 12, for sending to printing devices managed by network management device 20. Print queue policy rules 59 comprise a predetermined set of rules and/or rules

entered by a system administrator for governing how
print queues are created and published for each of the
printing devices which is managed by network management
device 20 as discussed further below. Print drivers 60
5   are print drivers for supporting the various printing
devices managed by network management device 20 and
print queues 61 are print queues created for the
printing devices management by network management
device 20. Lastly, other files 62 comprise other files
10 and applications necessary to implement the present
invention and to provide additional functionality to
network management device 20.

            Figure 3 is a block diagram for showing the
contents of directories 54. Specifically, directories
15 54 includes device management directory 70, print queue
configuration directory 71 and services directories 72.
Device management directories 70 include one or more
device management directory which is used to store
network identification and configuration information
20 for each printing device managed by network management
device 20 and is explained in further detail below.
Print queue configuration directory 71 is a directory
which contains printer identification information and
printer capability information along with other
25 information for each print queue which is created
corresponding to a printing device managed by network
management device 20. Services directories 72 include
a variety of services directories for tracking and
managing the functional services supported by one or
30 more network management devices for the plurality of
printing devices supported by the network management
devices. Services directories 72 is discussed in more
detail below.

            Figure 4 is a block diagram for explaining
35 the contents of servers 55. As seen in Figure 4,
servers 55 includes DHCP server 75, web server 76,
print server 77 and SNMP agent 78. DHCP server 75

allows network management device 20 to assign IP
addresses to the plurality of printing devices which it
manages, as well as to other devices on network 10.
DHCP server 75 also has the capability to provide a

5   software hook to which other modules can register.   In
this manner, when DHCP server 75 assigns an IP address
to a printing device on network 10 and then receives an
address acknowledgment message from the printing
device, DHCP server 75 notifies, through the software

10 hook, the registered software module of the IP address
of printing device. This is used to trigger a
discovery module to then perform targeted discovery of
the printing device, as discussed more fully herein.
In the alternative, network management device 20 can be

15 configured to disable DHCP server 75 when an external
DHCP server is utilized on network 10.   This
functionality is discussed in further detail below.
Web server 76 is a typical web server and is used to
publish web pages maintained by network management

20 device 20 to other entities on network 10, such as
workstations 11 and 12, or server 14. Print server 77
is a print server for managing print queues for one or
more printing devices managed by network management
device 20. Lastly, SNMP agent 78 allows network

25 management device 20 to communicate with other network
devices such as printing devices, over network 10 in
order to send and receive network configuration
information and other information related to the
printing device. Preferably, SNMP agent 78 initiates

30 SNMP communication between network management device 20
and other network devices which contain an SNMP agent
for responding to the SNMP communications.
        Figure 5 is a block diagram for explaining
the contents of software modules 56 which includes DHCP

35 listening module 80, virtual device modules 81,
functional application modules 82, print queue service
module 83, discovery module 84, and print queue service

manager module 85, and discovery service manager module
87. DHCP listening module 80 is a module which can be
used when an external DHCP server is utilized outside
of network management device 20, instead of DHCP server
5 75. In such a configuration, DHCP listening module 80
can be used to detect printing devices on network 10
based on the assignment of an IP address to a printing
device by the external DHCP server. This functionality
of DHCP listening module 80 is discussed more fully
10 below.

      Virtual device modules 81 comprise one or
more virtual device module which can be initiated in
correspondence to one or more printing devices
supported by network management device 20 so as to
15 extend functional capability of the printing devices.
For example, a virtual device module may be executed to
provide secure printing functionality on behalf of
printing devices which are managed by network
management device 20 and which do not have secure
20 printing functionality embedded therein. It should be
appreciated that such additional functionality can also
be implemented in software without the use of a virtual
device module.

      Functional application modules 82 comprise
25 modules for performing various applications such as
network secure printing, and which interface with
virtual device modules 81 to implement the functional
services, such as secure printing, which are not
directly supported by one or more printing devices
30 managed by network management device 20. Functional
application modules are discussed in more detail below.
Print queue service module 83 interfaces with discovery
module 84 to create a new print queue when a new
printing device is discovered.

35   Discovery module 84 is a module which is used
to perform discovery on detected printing devices on
network 10 so as to obtain information regarding a

printing device's network settings, and functional
capabilities. Depending on the mode of operation of
network management device 20, discovery module 84 can
receive notification of a detected printing device
5   through a software hook from DHCP server 75, from
classic discovery methods and/or from DHCP listening
module 80. The functionality of discovery module 84
and print queue service module 83 is discussed in more
detail below.

10   Print queue service manager module 85 is a
management application which allows multiple network
management devices on a same network to avoid confusion
regarding the detection and discovery of printing
devices across the network and to distribute and share
15   the processing load of supporting the various printing
devices across the network between the multiple network
management devices based on available resources of each
network management device and based on the location of
each network management device within the network.
20   Print queue service manager module 85 is discussed in
more detail below. In a similar fashion, discovery
service manager module 87 manages the discovery modules
among multiple network management devices to prevent
confusion in the detection, discovery and management of
25   printing devices. Discovery service manager module 87
also has the capability to distribute the load for
performing discovery of printing devices on a given
network between multiple network management devices.
This functionality is discussed in more detail below.

30   Turning to Figure 6, web pages 57 is depicted
which contains network configuration web page 86, queue
service web page 88, and print queue web page 89.
Network configuration web page 86 allows a user,
preferably a system administrator, to have a web-based
35   interface for managing the configuration and
operational parameters of network management device 20,
or of multiple network management devices, at a single

location. In addition, network configuration web page
86 allows a user, such as a system administrator, to
configure and manage the printing devices which are
managed by network management device 20. Queue service
5   web page 88 allows a user, such as a system
administrator, to access and manage the print queues
for all printing devices managed by network management
device 20 and by any other network management devices
residing on network 10. Queue service web page 88
10 therefore allows a system administrator to view and
manage all print queues supported by network management
device 20 and other network management devices, and to
view and manage print jobs within each respective print
queue. Print queue web page 89 is a web page that is
15 accessible to users of network 10, such as workstations
11 and 12, in order to publish in one location all
available print queues managed by network management
device 20 and any other network management devices on
network 10 so that a user can quickly and efficiently
20 find a needed print queue and can also download print
driver corresponding to the printing device associated
with a designated print queue.

            Figure 7 is a block diagram for explaining
one of device management directories 70. As seen in
25 Figure 7, the device management directory is utilized
for containing identification and network configuration
information with respect to each printing device
detected and discovered by the present invention. In
particular, device management directory 70 contains a
30 plurality of entries 90, each entry corresponding to a
particular printing device which has been detected and
discovered by network management device 20. Based on
information discovered by network management device 20
from the respective device, a separate entry is created
35 for the printing device and identification information
related to the printing device, along with network
configuration information of the printing device, is

stored in the entry. For example, each of entries 90
has a field for entering the MAC address 91 of the
corresponding printing device. In addition, each entry
has a corresponding print device type 92 and IP address
5 93 for the printing device associated with the entry.
Lastly, network configuration information 94 contains
network-related information associated with the
printing device for the respective entry, such as
domain name and other network setting information. In
10 this manner, a directory is provided for maintaining
identification information and network configuration
information of each printing device managed by network
management device 20 for efficient access and
management by a network user, such as a system
15 administrator. When more than one network management
device is present across network 10, other device
management directories are created to provide a common
location for maintaining identity and network
configuration information for all printing devices
20 managed by all network management devices on the
network. This functionality is discussed in more
detail below.

      Figure 8 is a block diagram for explaining
print queue configuration directory 71. In particular,
25 print queue configuration directory 71 contains a
plurality of entries corresponding to each print queue
which is created by the present invention for each
printing device which is detected and discovered. When
a print queue is created for a printing device, the
30 configuration information related to the print queue is
stored in an entry in print queue configuration
directory 71 to maintain all print queue configuration
information in a common location. As seen in Figure 8,
each entry in print queue configuration directory 71
35 corresponds to a separate print queue and contains
information fields for IP address 100, MAC address 101,
print queue name 102, printing capabilities 103 and

server 105. IP address 100 contains the IP address of
the printing device corresponding to the print queue
entry and MAC address 101 also corresponds to the MAC
address for the printing device. Print queue name 102
5   is a name which is detected by discovery from the
corresponding printing device or, if it is not
detected, a name is generated when the print queue is
created. For example, print queue name 102 may
comprise a name which is simply the make and model of
10 the printing device which is discovered by network
management device 20 from the printing device. In a
similar fashion, printing capabilities 103 contains
printing capabilities of the printing device associated
with the print queue entry. For example, printing
15 capabilities 103 can include, but is not limited to,
color printing capabilities, recording sheet-size
capability such as letter and/or A4, and resolution
capabilities. Server 105 is the identity of the
network management device which is maintaining the
20 print queue for a given printing device. For example,
in a network environment having multiple network
management devices, different print queues may be
distributed among the multiple network management
devices in order to balance the processing throughput
25 and memory load required to maintain the print queues.

Figure 9 is a block diagram for explaining
the functionality of network management device 20 in
the network environment of network 10. As seen in
Figure 9, DHCP server 75 is provided in network
30 management device 20 for supporting DHCP communications
over network 10 using the DHCP protocol. In
particular, DHCP server 75 can be enabled, such as by a
system administrator through front panel 21, to respond
to all DHCP address requests on network 10 for an IP
35 address. In this configuration, DHCP server 75
supports a software hook to which discovery module 84
has preregistered. When DHCP server 75 receives a DHCP

address request from a device on network 10, DHCP
server 75 responds to the requesting device with an
assigned IP address. When DHCP server 75 receives an
address acknowledgment message from the requesting
5 device, DHCP server 75 uses the software hook to notify
discovery module 84 of the assignment of an IP address
to the requesting device. Discovery module 84 can then
determine if the requesting device is the type of
network device that discovery module 84 should perform
10 discovery on, and if so, discovery module 84 sends a
discovery request message to the device to obtain
information regarding the device's network settings, as
well as device capabilities and configuration. A
predetermined range of MAC addresses can be used by
15 discovery module 84 to determine whether a device
detected by DHCP server 75 is one for which discovery
module 84 should perform discovery. In addition, a
predetermined MAC address range may also be used by
DHCP server 75 so that DHCP server 75 will only provide
20 assigned IP addresses to a preferred set of network
devices, such as network printers. Preferably,
discovery module 84 compares the MAC address of the
address acknowledgment message to the predetermined MAC
address range to determine if the device is a network
25 printer that should be discovered and managed by
network management device 20.

          In the alternative, network management device
20 can also be configured to disable DHCP server 75,
such as by a system administrator either through front
30 panel 21 or through network configuration web page 86.
For example, when an external DHCP module is used DHCP
server 75 is disabled to prevent addressing conflicts
and discovery module 84 conducts classic discovery to
discover all printing devices on network 10. Such
35 classic discovery of the printing devices can include,
but is not limited to, known techniques such as using
broadcast discovery messages, pinging through a list of

IP addresses, router table walking, and DNS lookup.
For example, an SNMP broadcast discovery message can be
sent and then discovery module 84 can send a targeted
SNMP discovery request to each responding printing
5   device. In the alternative, discovery module can ping
through a list of IP addresses and then send a targeted
SNMP discovery request to each responding printing
device. As another alternative, discovery module 84
can obtain router tables from the routers on the
10 network and then send an SNMP discovery request to each
printing device having an IP address in the routing
tables. Lastly, discovery module 84 can obtain a list
of assigned IP addresses from a DNS server on the
network and then send an SNMP discovery request to each
15 printing device having an IP address in the list. It
can be appreciated that other known methods of
discovery can be used by discovery module 84 to
discover printing devices on network 10 when an
external DHCP server is used instead of DHCP server 75
20 in network management device 20.

          In addition to classic discovery methods,
DHCP listening module 80 can be used to detect an IP
address acknowledgment message for a new requesting
printing device on network 10. In particular, DHCP
25 listening module 80 detects DHCP address acknowledgment
messages which contain an IP address for a new printing
device on network 10. For example, after boot-up of
network management device 20 in the configuration where
an external DHCP server is utilized, discovery module
30 84 uses classic discovery methods as discussed above to
discover the printing devices existing on network 10.

          After using such classic discovery, DHCP
listening module 80 can then be used to detect printing
devices which subsequently become operational on
35 network 10 by detecting the IP address acknowledgment
message sent from the DHCP server to the newly
incorporated printing device to the external DHCP

server. In this manner, DHCP listening module 80 can
be used to augment classic discovery in order to
supplement the list of discovered printing devices
after initial boot-up of network management device 20.
5 DHCP listening module 80 also uses a software hook, to
which discovery module 84 has preregistered, to notify
discovery module 84 when a newly incorporated printing
device has been detected. Discovery module 84 then
initiates a discovery process for obtaining information
10 from the newly incorporated printing device, as
discussed in more detail below. DHCP listening module
80 can also use a MAC address range in order to listen
only for IP address acknowledgment messages
corresponding to a particular class of network devices,
15 such as network printers.

As discussed above, when an external DHCP
server is used, discovery module 84 uses classic
discovery methods to discover printing devices on
network 10, after which DHCP listening module 80 can be
20 used to discover subsequently incorporated printing
devices. On the other hand, when DHCP server 75 is
utilized, discovery module 84 is notified through the
software hook from DHCP server 75 of a detected
printing device. Regardless of the manner in which
25 discovery module 84 becomes aware of a detected
printing device, discovery module 84 initiates
discovery of information from the printing device.
Preferably, discovery module 84 sends an SNMP
information request to the detected printing device by
30 using the IP address of the detected printing device.
The detected printing device then responds with an SNMP
information message to provide the requested
information to discovery module 84. Discovery module
84 creates an entry for each discovered printing device
35 in device management directory 70. As discussed above,
the entry corresponding to each discovered device in
device management directory 70 includes the IP address,

MAC address, printing device type and network
configuration information corresponding to printer 18.
Discovery module 84 also notifies print queue service
module 83 of each discovered printing device so that
5   print queue service module 83 can create a new print
queue for the printing device and place the new print
queue in print queues 61. Print queue service module
83 also creates an entry in print queue configuration
directory 71 which contains identification information
10 for the printer, such as IP address, MAC address and
printing device type, as well as a print queue name and
printing device capabilities. In this manner, the
network configuration of printing devices is easily
managed and print queues are efficiently created and
15 maintained for the detected printing devices.

        Although the block diagram of Figure 9 shows
that network management device 20 is only using one of
network interfaces 44 and 45 for connecting to network
10, another configuration is supported by network
20 management device 20 in which one of the network
interfaces is used to connect to another network, such
as a local network on which only printing devices
reside. In such an environment, DHCP server 75 can be
configured to respond only to IP address requests from
25 printing devices on the second local network, thereby
leaving DHCP server 34 of server 14 to respond to all
other IP address requests on network 10. In this
manner, printing devices can be physically isolated
from all other network devices on network 10 to prevent
30 unauthorized use and managed use of the printing
devices connected to the second local network through
network management device 20. The functionality of
this embodiment is discussed in more detail below.

        As also seen in Figure 9, web server 76
35 allows web pages such as those described with respect
to Figure 6, to be published over the network to
network users, such as a user at workstation 12 or a

network administrator at server 14. Lastly, function
application modules 82 can provide network-wide
functional capabilities for the printing devices
managed by network management device 20 and interface
5   with virtual device containers 81 for supporting such
network applications on behalf of printing devices
managed by network management device 20. For example,
functional application modules 82 may include a secure
printing application which allows users on network 10
10   to provide print jobs to printing devices managed by
network management device 20 in a secure fashion. Even
though the printing devices do not have the embedded
functionality for supporting secure printing, virtual
device containers 81 act on behalf of their respective
15   printing devices to support such functionality. In
this manner, network management device 20 is an
extendable management tool for efficiently managing
printing devices on a network whereby additional
functionality can be added depending on the needs of
20   the particular network.

In addition, network management device 20 can
control a network device which it manages, such as a
network printer, so as to reconfigure the network
device for efficient operation under the management of
25   network management device 20. For example, if a
network printer is connected to network management
device 20 over the local network, then network
management device 20 can use SNMP messages to
reconfigure the network printer. Such reconfiguration
30   of the network printer can include, but is not limited
to, instructions for the network printer to stop
supporting certain protocols and to only use the
protocol which network management device 20 uses to
communicate with the network printer.

35   Figure 10 is a flowchart depicting a process
performed by network management device 20 to create
print queues corresponding to network printing devices

discovered on network 10. As discussed above,
discovery of network printing devices on network 10 is
coordinated through discovery module 84. In step
S1001, the discovery process is initiated when
5   discovery module 84 is activated by network management
device 20. In step S1002, discovery module 84
determines if network devices connected to network 10
have been detected and assigned IP addresses prior to
discovery module 84 becoming active. Checking for
10 previously detected network devices may occur in
different ways depending on the manner in which
discovery module 84 is being notified about newly
detected network printing devices. For example, if
DHCP server 75 is active and assigning new IP addresses
15 to requesting network devices, discovery module 84 will
query DHCP server 75 for all network printing devices
that have been assigned IP addresses prior to discovery
module 84 becoming active. On the other hand, if DHCP
server 75 is not active and an external DHCP server,
20 such as DHCP server 34, is being utilized to assign IP
addresses to requesting network devices, discovery
module 84 utilizes classic discovery methods (as
discussed above) to detect existing network devices.
Accordingly, discovery module 84 can identify all
25 network devices connected to the network and assigned
IP address prior to discovery module 84 becoming
active.

        If there are no existing network devices on
network 10 when discovery module 84 is initialized,
30 discovery module 84 waits for notification of a new
device in step S1004. Notification received by
discovery module 84 may be limited to network devices
with specific IP addresses or specific MAC addresses in
order to limit which network devices on network 10 will
35 be supported by network management device 20. For this
embodiment, we are assuming that discovery module 84
will only be notified of newly discovered printing

devices. Notification of a new device may come in
different ways as described earlier. For example, a
software hook within DHCP server 75 will notify
discovery module 84 of a new network device when an
5 address acknowledgment message is received by DHCP
server 75 from a network device that requested an IP
address. In the alternative, when an external DHCP
server is being used, DHCP listening module 80 will
listen on network 10 for an address acknowledgment
10 message from a network device requesting an address
from an external DHCP server and notify discovery
module 84 of any such network device. Regardless of
the manner in which discovery module 84 is notified of
a new printing device, the notification includes
15 sufficient identification information of that printing
device to allow discovery module to communicate with
the printing device. Such information might include,
but is not limited to, the IP address and the MAC
address of the newly detected printing device.
20   If discovery module 84 has been notified of a
new printing device, or in step S1002 an existing
printing device has been found, the print queue
creation process proceeds to step S1005 where discovery
module 85 obtains additional information from the
25 printing device. For purposes of this description,
assume that printer 18 is a newly detected printing
device. In step S1005, discovery module 84 sends an
information request message to printer 18 via SNMP
agent 78 using the IP address provided in the
30 notification. In response to the request message,
printer 18 sends a response which includes information
including, but not limited to, the type and model of
printer 18, as well as information regarding the
available functions and capabilities of printer 18.
35 The information might also include available paper
sizes, color capabilities, print speed, resolution,
etc. As discussed above, discovery module 84 uses this

information received from printer 18 to create an entry
in device management directory 70. Additionally,
discovery module 84 forwards this information to print
queue service module 83 in step S1006 so that print
5 queue service module 83 can use the information in the
creation of a print queue corresponding to printer 18.

In step S1008, print queue service module 83
creates a print queue corresponding to printer 18, and
configures the print queue using the information, such
10 as the addresses, printer type, configuration and
capabilities, obtained from printer 18 via SNMP agent
78 by discovery module 84. The created print queue is
named according to a set of predetermined rules set up
by a network administrator. For example, the print
15 queue may be named according to the make, model, IP
address or other attributes (or combination of
attributes) of the corresponding printer.
Additionally, a print queue name may be obtained from
printer 18 in the information obtained by discovery
20 module 84. Once configured, the newly created print
queue is stored within print queues 61. Accordingly, a
print queue can be created and configured automatically
for a newly detected network printing device (or a
previously detected printing device) without requiring
25 a network administrator to manually enter the
configuration information.

In addition to creating a print queue to be
associated with printer 18, print queue service module
83 creates a print queue entry in print queue
30 configuration directory 71. As discussed above, print
queue configuration directory 71 contains a plurality
of entries corresponding to print queues created and
configured by network management device 20 thereby
providing a common location for print queue
35 configuration information for all existing print queues
on network 10. As shown in Fig. 8, each entry in print
queue configuration directory 71 contains fields for IP

address, MAC address, print queue name, printing
capabilities and the server managing the print queue.
The fields for each entry are completed by print queue
service module 83 using the information used in
5   creating and configuring the particular print queue.

As mentioned earlier, print server 77 is a
print server for managing the print queues of one or
more printing devices managed by network management
device 20. Once a print queue is created and
10 configured by print queue service module 83, the print
queue is registered with print server 77. Print server
77 then proceeds to publish and make the print queue
available to client workstations connected to network
10 using conventional protocols such as SMB. In
15 addition, print server 77 may utilize print queue
policy rules 59 to regulate use of the print queues by
client workstations connected to network 10.

Network management device 20 maintains print
queue web page 89, which is stored within web pages 57,
20 using the print queue entries in print queue
configuration directory 71. As discussed above, print
queue web page 89 is a web page accessible to users of
network 10 in which all available print queues managed
by network management device 20 and any other network
25 management devices connected on network 20 are
published in a single location. Web server 76 is used
to publish print queue web page 89 over network 10,
thereby allowing a network user to access the listing
of available print queues using either a workstation,
30 like workstation 12, or a server, like server 14.

Figure 11 depicts a process for configuring a
client workstation to utilize a print queue ·
corresponding to one of the network printers, such as
printer 18. In step S1101, print queue web page 89 is
35 opened at workstation 12 using user interface 29 and a
conventional browser installed on host processor 26.
Viewing print queue web page 89, a network user at

workstation 12 can search a single listing of all
available print queues on network 10 and select a
particular print queue. Using user interface 29, a
network user may select a desired print queue.
5   Selection may be performed by typing in the print queue
name within user interface 29 or by selecting a link
associated with the desired print queue within print
queue web 89 page using a pointing device such as a
mouse.
10   In step S1102, network management device 20
receives the selection from the available print queues
made by the user at workstation 12. Network management
device 20 then searches print drivers 60 for the
appropriate print driver associated with the selected
15 print queue. In step S1104, Network management device
20 configures the client workstation by sending and
installing the appropriate print driver from print
drivers 60 on workstation 12 via network 10. Once the
print driver is installed on workstation 12, in step
20 S1105 network management device 20 establishes a
connection between workstation 12 and print server 77,
thereby allowing print jobs to be sent from workstation
12 to the selected print queue. The present invention
is not limited to the method described above for
25 configuring a client workstation. For example, the
network and the client workstations may utilize an
operating system and printing protocol which do not
utilize print drivers, such as a UNIX based system. In
that case, network management device 20 would execute
30 the necessary functions in step S1104 to make it
possible for the requesting client workstation to
establish a connection in step S1105.
        In the course of managing a computer network,
network devices may need to be relocated or replaced.
35 When a device is relocated, it may need to have a new
IP address assigned to it for communication within the
network. In addition, when dynamic hosting protocols

such as DHCP are used to administer IP addresses,
situations may arise where a network device is assigned
a new IP address. If a network printing device is
assigned a new IP address, it is essential that the
5   print queue associated with that printing device is
updated with the new IP address in order to maintain
consistency for the client workstations connected to
that particular print queue for printing purposes. The
flowchart depicted in Figure 12 demonstrates a process
10 for automating the task of updating print queue
configurations with new IP addresses.

        As described with reference to Figure 10,
either by DHCP server 75 or by DHCP listening module 80
detects the assignment of IP addresses to network
15 devices and notifies discovery module 84. For the
purposes of this example, assume printer 18 has been
relocated on network 10 and is assigned a new IP
address by DHCP server 75. In step S1201, the
assignment of an IP address to printer 18 is detected.
20 In step S1202, discovery module 74 is notified that
printer 18 has been assigned a new IP address, and
discovery module 84 is provided with the IP address
assigned to printer 18 and the MAC address of printer
18.

25   Upon receiving notification that printer 18
has been assigned an IP address, in step S1203
discovery module 84 compares the MAC address of printer
18 with those listed in the entries of device
management directory 70. Since printer 18 was
30 previously connected to network 10, an entry is found
under the MAC address of printer 18 together with its
previous IP address. Using the pair of address (IP and
MAC) from the entry, print queue service module 83 can
identify a previously created print queue associated
35 with printer 18 by referring to print queue
configuration directory 71. Once the print queue is
identified, the process proceeds to step S1205. In

step S1205, discovery module 84 instructs print queue
service module 83 to update the configuration of the
print queue in print queues 61 associated with printer
18 so that the IP address reflects the newly assigned

5   IP address. In addition, in step S1206, print queue
service module 83 updates the IP address entry for the
print queue in print queue configuration directory 71
to reflect the new IP address of printer 18.
Accordingly, all network users with connections to the

10   print queue associated with printer 18 will be able to
maintain their connections without interruption due to
the IP address change. Additionally, the network
administrator is not required to manually change the
configuration or entry in print queue configuration

15   directory 71.
         The process described with reference to
Figure 12 is an expansion of the process described in
step S1004 with reference to Figure 10. In the event
that no match is found by discovery module 84 in step

20   S1203, the detected network device has not been
previously detected (or at least not within a
predetermined time frame). The process then proceeds
to step S1005 within Figure 10 and a print queue is
created according to the process described there.

25   In addition to print queue web page 89,
network management device 20 also maintains queue
service page 88, which allows users, preferably network
administrators, to access and manage the print queues
associated with printing devices managed by network

30   management device 20 and any other network management
devices connected to network 10. Web server 76
publishes queue service page 88, thereby allowing a
user to access the page from a server, such as server
14, using user interface 32.

35   Queue service web page 88 provides a user
with many functions. For example, using queue service
web page 88, a user can perform queue management

functions including, but not limited to, manually
creating or removing print queues, pausing and resuming
the operation of a print queue, purging a print queue,
and editing the driver associated with a print queue.
5   In addition, queue service web page 88 allows a user to
manage individual print jobs within individual print
queues. For example, a print job may be paused,
restarted, cancelled or reordered. Accordingly, queue
service page 88 affords a user a large amount of
10   control over print queues associated with the printing
devices of network 10.

     As mentioned above, queue service web page 88
allows a user to manage existing print queues on
network 10. Using queue service web page 88, an
15   administrator may rename the queue associated with
printer 18 using queue service web page 88. However,
if the name of a print queue is changed, all network
devices, such as workstation 12, that use that
particular print queue, will no longer have a
20   connection with printer 18. Each network device with a
connection to printer 18 must learn the new print queue
name of the print queue associated with printer 18, and
the configuration on each network device must be
modified to reflect the new print queue name.
25   Additionally, a network administrator may reassign a
particular print queue to a different server during
network administration or to provide for load
balancing. As with changing the name of a print queue,
all network devices with a connection to printer 18
30   must have their connection updated to reflect the new
server in order to continue to use printer 18
corresponding to the particular print queue.

     Figure 13 is a flowchart depicting a process
for updating print queue connections when the
35   identification information of a print queue has been
changed. For example, the name of a print queue may be
changed to provide for easier identification of a

particular print queue. Additionally, a print queue
may be moved to a different server by a network
administrator while organizing the network or to
facilitate load balancing among multiple printers
5   available on the network. Regardless of the type of
change, when the identification information of a print
queue is modified, client workstations on the network
will no longer be able to send print jobs to the
modified print queue until their connections have been
10   updated.

         In step S1301, the identification information
of a print queue within print queues 61 is modified
either by a network administrator or another process
operating on network management device 20. In step
15   S1302, print queue service module 83 compares the
identification information of the modified print queue
with the entry in print queue configuration directory
71 corresponding to the modified print queue, and
modifies the entry to reflect the changes made to the
20   particular print queue. In step S1304, print queue
service module 83 identifies client workstations
connected to network 10 which are configured to utilize
the modified print queue by querying print server 77.
Finally, in step S1305, the connection between a client
25   workstation identified in step S1304 and the modified
print queue is updated to reflect the new
identification information of the print queue.
Accordingly, client workstations connected to network
10 can continue to use print queues within print queues
30   61 regardless of any modifications made to print queue
identification information.

         The procedure for updating a print queue
connection, described with reference to step S1305
above, may vary depending on the network configuration
35   or the protocol used for communicating between the
client workstation and the printer. For example, when
a print queue is modified, network management device 20

may simply notify software installed on the identified
client workstation of the new identification
information using a protocol such as SNMP. The
software would then update the configuration on the
5   client workstation. Alternatively, the client
workstation may allow remote configuration thereby
allowing a network administrator or a module within
network management device 20 to remotely configure the
client workstation with the new identification
10 information of the print queue. Other embodiments may
utilize other protocols such as LPD, providing a level
of indirection and allowing the connection
configuration to be updated within the print server.
Regardless of the updating method being used, the
15 present invention maintains the connection between a
client workstation and a print queue without requiring
action from a network user of the client workstation.

          As mentioned above, using queue service web
page 88, an administrator can manually create a print
20 queue for a network printing device. While the present
invention can automatically detect a new printing
device and create a print queue for that printing
device, situations may arise where manual creation of
print queues is required. For example, the auto-create
25 feature of the invention may be disabled by an
administrator via queue service web page 88.
Additionally, an administrator may designate a maximum
number of printing devices or may designate an IP
address (or MAC address) range of printing devices to
30 be supported by network management device 20 using
queue service web page 88. Upon being notified of a
new printing device by discovery module 84, print queue
service module 83 will not proceed with the automatic
creation of a print queue when the existing number of
35 print queues being supported by network management
device 20 has reached a maximum number set by a network
administrator or if the IP address (or MAC address)

falls outside of a predetermined range. If an
administrator wishes to add another print queue under
these situations, as well as others, manual creation of
the print queue must be performed using queue service
5   web page 88. Figure 14 depicts a process for manually
creating a print queue for a network printing device.

    In step S1401, a user, preferably a network
administrator, selects manual print queue creation
using queue service web page 88. Queue service web
10 page 88 then provides an interface for the user to
create and configure a print queue for a particular
network printing device. In step S1402, the user is
given the option of creating a print queue for either a
previously discovered printing device or new printing
15 device. If the user selects creating a print queue for
a new printing device, the user then provides
identification information about the printing device in
step S1404, thereby allowing network management device
20 to contact the printing device over network 10 to
20 obtain additional information from the printing device.
The provided identification information includes, but
is not limited to, the IP address of the printing
device as well as the type of printing device.

    If the user opts to create a print queue for
25 a previously detected printing device in step S1402,
the user is provided with a list of current printing
devices. The list is generated by referring to device
management directory 70, which as described above,
contains an entry for each network device detected by
30 network management device 20. The user then selects
from the list of current printing devices in step
S1405. Alternatively, the list from which the user
selects a printing device could be generated by
discovery module 84 performing one of the classic
35 discovery methods discussed earlier to compile a
current list of network devices. Once discovery had
been completed by discovery module 84, the list would

then be generated and displayed for the user to select from.

After the user has entered identification information for the printing device in step S1404, or selected a current printing device in step S1405, the process proceeds to step S1406 where the parameters required for configuring the new print queue are obtained. Discovery module 84 obtains additional information from the printing device using a service such as SNMP agent 78 as described above regarding step S1005 in Figure 10. Additionally, the user is prompted for information needed to establish other properties of the print queue such as load balancing, fail over printing, automatic share reconfiguration, etc. Once all the necessary information has been obtained from the printing device and the user, print queue service module 83 is provided with the obtained information and instructed to create a print queue in step S1408. In step S1408, Print queue service module 83 creates a print queue in the manner described above regarding step S1008 in figure 10.

The present invention has been described with particular illustrative embodiments. It is to be understood that the invention is not limited to the above-described embodiments and the various changes and modifications may be made by those of ordinary skill in the art without departing from the spirit and scope of the invention.